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To: . Ms. B. S. Mait **Date:** April 6, 1989

From: . P. D. Lieberman

Subject: . Statistical Analysis of Firmness and Oven Volatiles Data for the CTSD-PME Collaborative Study

The attached tables contain a summary of the results obtained in the CTSD-PME Firmness Collaborative Study. As is firmness testing was performed at three sets of conditions: FTC conditions at CTSD, ISO conditions at CTSD and ISO conditions at PME. FTC conditions are 75°F and 60% relative humidity while ISO conditions are 71.6°F and 60% relative humidity.

Tables I and II contain the firmness and oven volatiles data for the three sets of conditions. The reported means were calculated by eliminating any values which were greater than one standard deviation from the mean of all the data. There were very few outliers and the elimination of those that did exist had little or no effect on the mean. Also, note that there were 20 observations for the samples tested under CTSD FTC conditions and only 15 observations for the remaining two conditions. During the testing at CTSD FTC conditions, a power outage occurred and an additional test was performed to insure the integrity of the data. However, the samples which were run after the power outage were not significantly different and were therefore included in the study. Since the number of observations (N) for each sample is not the same, the standard error of the mean (SEM), which accounts for N, is also included in the tables.

Tables III and IV contain a comparison of firmness and oven volatiles at CTSD FTC and CTSD ISO conditions. The firmness values generated under the ISO conditions at CTSD were consistently lower than those generated under the FTC conditions. All differences were statistically significant except for sample H which had an unacceptably high standard deviation (0.23 mm). Of the remaining samples, the firmness indexes generated under the ISO conditions at CTSD were 0.08 to 0.16 mm lower than those generated under the FTC conditions at CTSD. This agrees with results seen in previous studies. The oven volatiles of the samples tested under CTSD ISO conditions were consistently lower than those tested under CTSD FTC conditions, though not all the differences were statistically significant. This also agrees with past results.

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Tables V and VI contain a comparison of firmness and oven volatiles at CTSD ISO and PME ISO conditions. Note that the ISO condition is the same for both; it is the location of testing that varied. The firmness values generated under the ISO conditions at PME were consistently lower than those generated under the ISO conditions at CTSD. All differences were statistically significant. The firmness indexes generated under the ISO conditions at PME were 0.13 to 0.27 mm lower (excluding sample H which had a difference of 0.31 mm) than those generated under the ISO conditions at CTSD. The oven volatiles of the samples tested under the two conditions showed no trends. Most differences were not statistically significant.

Tables VII and VIII contain a comparison of firmness and oven volatiles at CTSD FTC and PME ISO conditions. The firmness values generated under the ISO conditions at PME were consistently lower than those generated under the FTC conditions at CTSD. All differences were statistically significant. The firmness indexes generated under the ISO conditions at PME were 0.25 to 0.43 mm lower than those generated under the FTC conditions at CTSD. The oven volatiles of the samples tested under the two conditions showed no trends. Most differences were not statistically significant.

Figure I is a plot of the firmness indexes determined at ISO conditions at PME versus those determined at FTC conditions at CTSD: the usual conditions at each laboratory. Linear regression of the data resulted in the following equation ($R^2 = 0.96$):

$$\text{PME ISO} = 0.92 * (\text{CTSD FTC}) - 0.088$$

For example, a firmness index of 3.3 determined at CTSD would correspond to an index of 2.95 determined at PME.

Three filter samples, F1, F2 and F3, were tested before and after the firmness analyses each day of testing. Table IX contains the filter firmness results. Note that the filters were tested directly from the can and, therefore, should not be affected by the environmental conditions. At the 99% confidence level, the filters tested under the CTSD FTC and CTSD ISO conditions were not significantly different. The filters tested under the PME ISO conditions were significantly lower than both the CTSD FTC and CTSD ISO conditions. Filters tested at PME ranged from 0.14 to 0.28 mm lower than those tested at CTSD. The firmness indexes determined for the F2 and F3 filters at PME were, however, within the firmness range that was determined during initial testing of those filters. The F1 filters which have been in use since November 1988, have averaged 3.60 mm firmness over a period of 4 months. The CTSD FTC and CTSD ISO filter firmness tests were well within the range determined for the F1 filters. The F1 filters tested at PME were consistently below the lower control limit for the filters.

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Table I

As Is Firmness Comparison
CTSD FTC, CTSD ISO and PME ISO Conditions

Sample Code		CTSD FTC 75°F,60% RH	CTSD ISO 71.6°F,60% RH	PME ISO 71.6°F,60% RH
A	Mean	2.76	2.66	2.39
	SD ±	0.07	0.10	0.08
	N	20	15	14
	SEM	0.02	0.03	0.02
D	Mean	3.17	3.09	2.85
	SD ±	0.11	0.12	0.09
	N	20	15	15
	SEM	0.03	0.03	0.02
F	Mean	3.24	3.08	2.87
	SD ±	0.06	0.06	0.11
	N	18	13	14
	SEM	0.02	0.02	0.03
G	Mean	3.42	3.26	2.99
	SD ±	0.11	0.12	0.14
	N	20	15	15
	SEM	0.03	0.03	0.04
H	Mean	3.60	3.56	3.25
	SD ±	0.15	0.23	0.13
	N	19	15	15
	SEM	0.03	0.06	0.03
I	Mean	3.30	3.19	2.95
	SD ±	0.10	0.09	0.11
	N	20	14	15
	SEM	0.02	0.02	0.03
J	Mean	3.17	3.06	2.87
	SD ±	0.09	0.07	0.11
	N	19	14	15
	SEM	0.02	0.02	0.03
M	Mean	2.93	2.81	2.68
	SD ±	0.12	0.06	0.13
	N	19	15	15
	SEM	0.03	0.02	0.03

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Table II

As Is Firmness Oven Volatiles Comparison
CTSD FTC, CTSD ISO and PME ISO Conditions

Sample Code		CTSD FTC 75°F,60% RH	CTSD ISO 71.6°F,60% RH	PME ISO* 71.6°F,60% RH
A	Mean	12.43	12.34	12.5
	SD ±	0.07	0.09	0.1
	N	19	13	15
	SEM	0.02	0.02	0.03
D	Mean	12.76	12.72	12.7
	SD ±	0.11	0.09	0.1
	N	19	13	15
	SEM	0.03	0.02	0.03
F	Mean	12.73	12.59	12.7
	SD ±	0.19	0.06	0.1
	N	20	12	15
	SEM	0.04	0.02	0.03
G	Mean	12.95	12.89	12.8
	SD ±	0.14	0.11	0.1
	N	19	14	14
	SEM	0.03	0.03	0.03
H	Mean	12.25	12.14	12.4
	SD ±	0.11	0.11	0.1
	N	19	15	14
	SEM	0.03	0.03	0.03
I	Mean	11.76	11.74	11.8
	SD ±	0.12	0.15	0.1
	N	19	15	15
	SEM	0.03	0.04	0.04
J	Mean	12.90	12.75	12.8
	SD ±	0.12	0.08	0.1
	N	19	14	14
	SEM	0.03	0.02	0.03
M	Mean	12.72	12.69	12.8
	SD ±	0.12	0.08	0.2
	N	19	14	15
	SEM	0.03	0.02	0.05

*Oven Volatiles data recorded to one (1) decimal place.

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Table III

As Is Firmness Comparison
CTSD FTC versus CTSD ISO Conditions

Sample Code		CTSD FTC 75°F, 60% RH	CTSD ISO 71.6°F, 60% RH	Difference[a]
A	Mean	2.76	2.66	+0.10
	SD ±	0.07	0.10	
	N	20	15	
	SEM	0.02	0.03	
D	Mean	3.17	3.09	+0.08
	SD ±	0.11	0.12	
	N	20	15	
	SEM	0.03	0.03	
F	Mean	3.24	3.08	+0.16
	SD ±	0.06	0.06	
	N	18	13	
	SEM	0.02	0.02	
G	Mean	3.42	3.26	+0.16
	SD ±	0.11	0.12	
	N	20	15	
	SEM	0.03	0.03	
H	Mean	3.60	3.56	+0.04[b]
	SD ±	0.15	0.23	
	N	19	15	
	SEM	0.03	0.06	
I	Mean	3.30	3.19	+0.11
	SD ±	0.10	0.09	
	N	20	14	
	SEM	0.02	0.02	
J	Mean	3.17	3.06	+0.11
	SD ±	0.09	0.07	
	N	19	14	
	SEM	0.02	0.02	
M	Mean	2.93	2.81	+0.12
	SD ±	0.12	0.06	
	N	19	15	
	SEM	0.03	0.02	

[a]Difference = CTSD FTC Determination - CTSD ISO Determination

[b]Difference is not statistically significant based on the variance of the data.

Source: https://www.industrydocuments.ucsf.edu/docs/tfpk0001

Table IV

As Is Firmness Oven Volatiles Comparison
CTSD FTC versus CTSD ISO Conditions

Sample Code		CTSD FTC 75°F, 60% RH	CTSD ISO 71.6°F, 60% RH	Difference[a]
A	Mean	12.43	12.34	+0.09
	SD ±	0.07	0.09	
	N	19	13	
	SEM	0.02	0.02	
D	Mean	12.76	12.72	+0.04[b]
	SD ±	0.11	0.09	
	N	19	13	
	SEM	0.03	0.02	
F	Mean	12.73	12.59	+0.14
	SD ±	0.19	0.06	
	N	20	12	
	SEM	0.04	0.02	
G	Mean	12.95	12.89	+0.06[b]
	SD ±	0.14	0.11	
	N	19	14	
	SEM	0.03	0.03	
H	Mean	12.25	12.14	+0.11
	SD ±	0.11	0.11	
	N	19	15	
	SEM	0.03	0.03	
I	Mean	11.76	11.74	+0.02[b]
	SD ±	0.12	0.15	
	N	19	15	
	SEM	0.03	0.04	
J	Mean	12.90	12.75	+0.15
	SD ±	0.12	0.08	
	N	19	14	
	SEM	0.03	0.02	
M	Mean	12.72	12.69	+0.03[b]
	SD ±	0.12	0.08	
	N	19	14	
	SEM	0.03	0.02	

[a]Difference = CTSD FTC Determination - CTSD ISO Determination

[b]Difference is not statistically significant based on the variance of the data.

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Table V

As Is Firmness Comparison
CTSD ISO versus PME ISO Conditions

Sample Code		CTSD ISO 71.6°F, 60% RH	PME ISO 71.6°F, 60% RH	Difference[a]
A	Mean	2.66	2.39	+0.27
	SD ±	0.10	0.08	
	N	15	15	
	SEM	0.03	0.02	
D	Mean	3.09	2.85	+0.24
	SD ±	0.12	0.09	
	N	15	15	
	SEM	0.03	0.02	
F	Mean	3.08	2.87	+0.21
	SD ±	0.06	0.11	
	N	13	14	
	SEM	0.02	0.03	
G	Mean	3.26	2.99	+0.27
	SD ±	0.12	0.14	
	N	15	15	
	SEM	0.03	0.04	
H	Mean	3.56	3.25	+0.31
	SD ±	0.23	0.13	
	N	15	15	
	SEM	0.06	0.03	
I	Mean	3.19	2.95	+0.24
	SD ±	0.09	0.11	
	N	14	15	
	SEM	0.02	0.03	
J	Mean	3.06	2.87	+0.19
	SD ±	0.07	0.11	
	N	14	15	
	SEM	0.02	0.03	
M	Mean	2.81	2.68	+0.13
	SD ±	0.06	0.13	
	N	15	15	
	SEM	0.02	0.03	

[a]Difference = CTSD ISO Determination - PME ISO Determination

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Table VI

As Is Firmness Oven Volatiles Comparison
CTSD ISO versus PME ISO Conditions

Sample Code		CTSD ISO 71.6°F,60% RH	PME ISO* 71.6°F,60% RH	Difference[a]
A	Mean	12.34	12.5	-0.16
	SD ±	0.09	0.1	
	N	13	15	
	SEM	0.02	0.03	
D	Mean	12.72	12.7	+0.02[b]
	SD ±	0.09	0.1	
	N	13	15	
	SEM	0.02	0.03	
F	Mean	12.59	12.7	-0.11[b]
	SD ±	0.06	0.1	
	N	12	15	
	SEM	0.02	0.03	
G	Mean	12.89	12.8	+0.09[b]
	SD ±	0.11	0.1	
	N	14	14	
	SEM	0.03	0.03	
H	Mean	12.14	12.4	-0.26
	SD ±	0.11	0.1	
	N	15	14	
	SEM	0.03	0.03	
I	Mean	11.74	11.8	-0.06[b]
	SD ±	0.15	0.1	
	N	15	15	
	SEM	0.04	0.04	
J	Mean	12.75	12.8	-0.05[b]
	SD ±	0.08	0.1	
	N	14	14	
	SEM	0.02	0.03	
M	Mean	12.69	12.8	-0.11
	SD ±	0.08	0.2	
	N	14	15	
	SEM	0.02	0.05	

*Oven Volatiles data recorded to one (1) decimal place

[a]Difference = CTSD ISO Determination - PME ISO Determination

[b]Difference is not statistically significant based on the variance of the data.

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Table VII

As Is Firmness Comparison
CTSD FTC versus PME ISO Conditions

Sample Code		CTSD FTC 71.6°F, 60% RH	PME ISO 71.6°F, 60% RH	Difference[a]
A	Mean	2.76	2.39	+0.37
	SD ±	0.07	0.08	
	N	20	14	
	SEM	0.02	0.02	
D	Mean	3.17	2.85	+0.32
	SD ±	0.11	0.09	
	N	20	15	
	SEM	0.03	0.02	
F	Mean	3.24	2.87	+0.37
	SD ±	0.06	0.11	
	N	18	14	
	SEM	0.02	0.03	
G	Mean	3.42	2.99	+0.43
	SD ±	0.11	0.14	
	N	20	15	
	SEM	0.03	0.04	
H	Mean	3.60	3.25	+0.35
	SD ±	0.15	0.13	
	N	19	15	
	SEM	0.03	0.03	
I	Mean	3.30	2.95	+0.35
	SD ±	0.10	0.11	
	N	20	15	
	SEM	0.02	0.03	
J	Mean	3.17	2.87	+0.30
	SD ±	0.09	0.11	
	N	19	15	
	SEM	0.02	0.03	
M	Mean	2.93	2.68	+0.25
	SD ±	0.12	0.13	
	N	19	15	
	SEM	0.03	0.03	

[a]Difference = CTSD FTC Determination - PME ISO Determination

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Table VIII

As Is Firmness Oven Volatiles Comparison
CTSD FTC versus PME ISO Conditions

Sample Code		CTSD FTC 71.6°F,60% RH	PME ISO* 71.6°F,60% RH	Difference[a]
A	Mean	12.43	12.5	-0.07[b]
	SD ±	0.07	0.1	
	N	19	15	
	SEM	0.02	0.03	
D	Mean	12.76	12.7	+0.06[b]
	SD ±	0.11	0.1	
	N	19	15	
	SEM	0.03	0.03	
F	Mean	12.73	12.7	+0.03[b]
	SD ±	0.19	0.1	
	N	20	15	
	SEM	0.04	0.03	
G	Mean	12.95	12.8	+0.15
	SD ±	0.14	0.1	
	N	19	14	
	SEM	0.03	0.03	
H	Mean	12.25	12.4	-0.15
	SD ±	0.11	0.1	
	N	19	14	
	SEM	0.03	0.03	
I	Mean	11.76	11.8	-0.04[b]
	SD ±	0.12	0.1	
	N	19	15	
	SEM	0.03	0.04	
J	Mean	12.90	12.8	+0.10
	SD ±	0.12	0.1	
	N	19	14	
	SEM	0.03	0.03	
M	Mean	12.72	12.8	-0.08[b]
	SD ±	0.12	0.2	
	N	19	15	
	SEM	0.03	0.05	

*Oven Volatiles data recorded to one (1) decimal place.
[a]Difference = CTSD FTC Determination - PME ISO Determination

[b]Difference is not statistically significant based on the variance of the data.

Source: https://www.industrydocuments.ucsf.edu/docs/tfpk0001

Table IX

Filter Firmness Comparison
CTSD FTC, CTSD ISO and PME ISO Conditions

Filter Code			CTSD FTC 75°F, 60% RH	CTSD ISO 71.6°F, 60% RH	PME ISO 71.6°F, 60% RH
F1	Pre Day 1	mean	3.62	3.68	3.39
		sd ±	0.19	0.11	0.02
	Post Day 1	mean	3.62	3.62	3.37
		sd ±	0.16	0.03	0.07
	Pre Day 2	mean	3.74	3.65	3.38
		sd ±	0.12	0.08	0.08
	Post Day 2	mean	3.63	3.67	3.37
		sd ±	0.13	0.10	0.07
F1	**Grand Mean**		**3.66**	**3.66**	**3.38**[a]
F2	Pre Day 1	mean	2.38	2.57	2.28
		sd ±	0.07	0.13	0.07
	Post Day 1	mean	2.48	2.34	2.37
		sd ±	0.07	0.05	0.06
	Pre Day 2	mean	2.57	2.47	2.30
		sd ±	0.07	0.10	0.11
	Post Day 2	mean	2.40	2.48	2.30
		sd ±	0.08	0.04	0.08
F2	**Grand Mean**		**2.45**	**2.47**	**2.31**[a]
F3	Pre Day 1	mean	3.13	3.15	2.97
		sd ±	0.07	0.10	0.03
	Post Day 1	mean	3.08	3.02	2.96
		sd ±	0.06	0.05	0.03
	Pre Day 2	mean	3.23	3.09	2.83
		sd ±	0.06	0.11	0.10
	Post Day 2	mean	3.09	3.04	2.83
		sd ±	0.08	0.09	0.05
F3	**Grand Mean**		**3.12**	**3.07**	**2.90**[a]

[a]Value is statistically different from the other two conditions.

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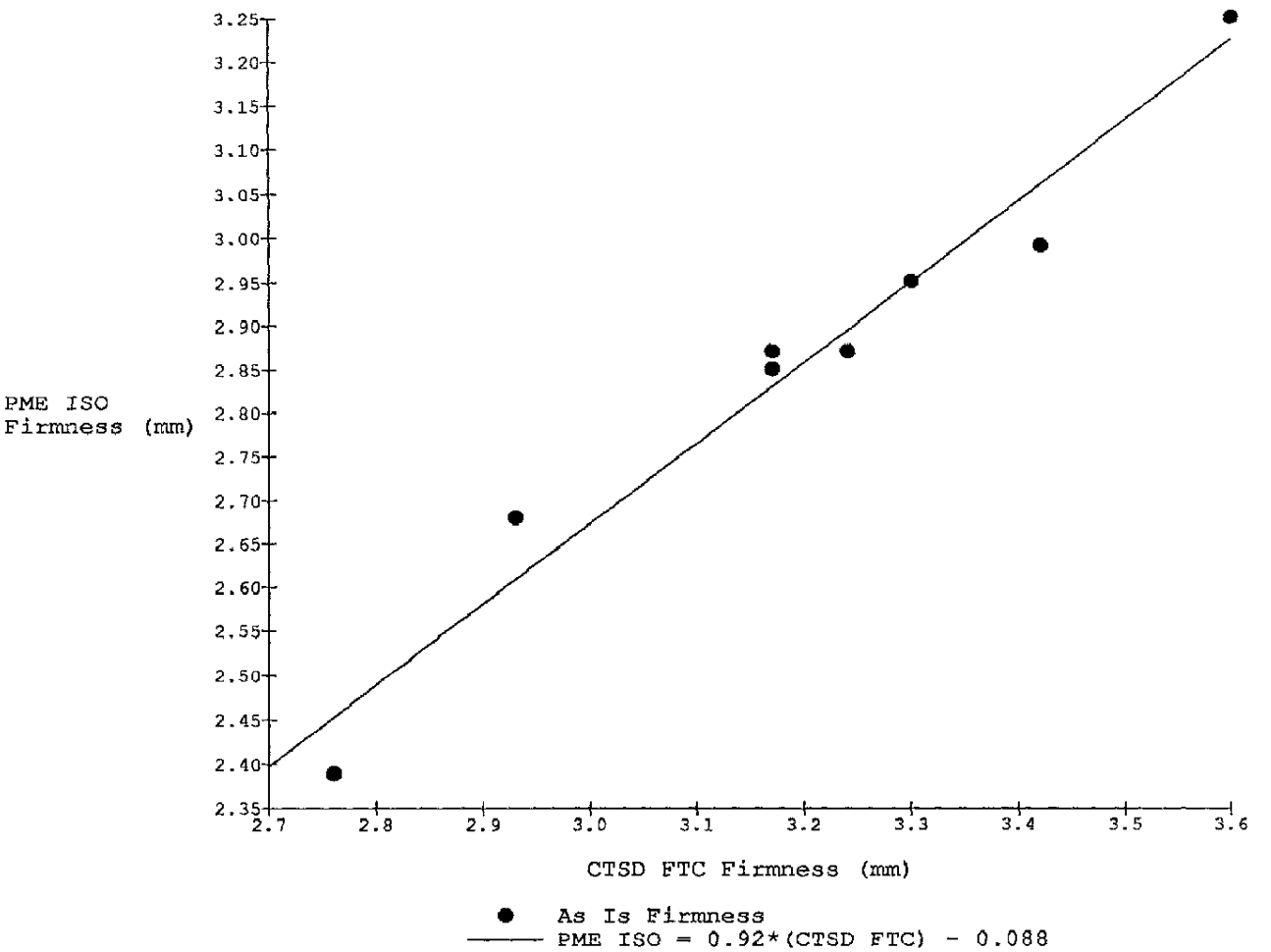
Figure I

As Is Firmness
CTSD FTC versus PME ISO



R2 = 0.96

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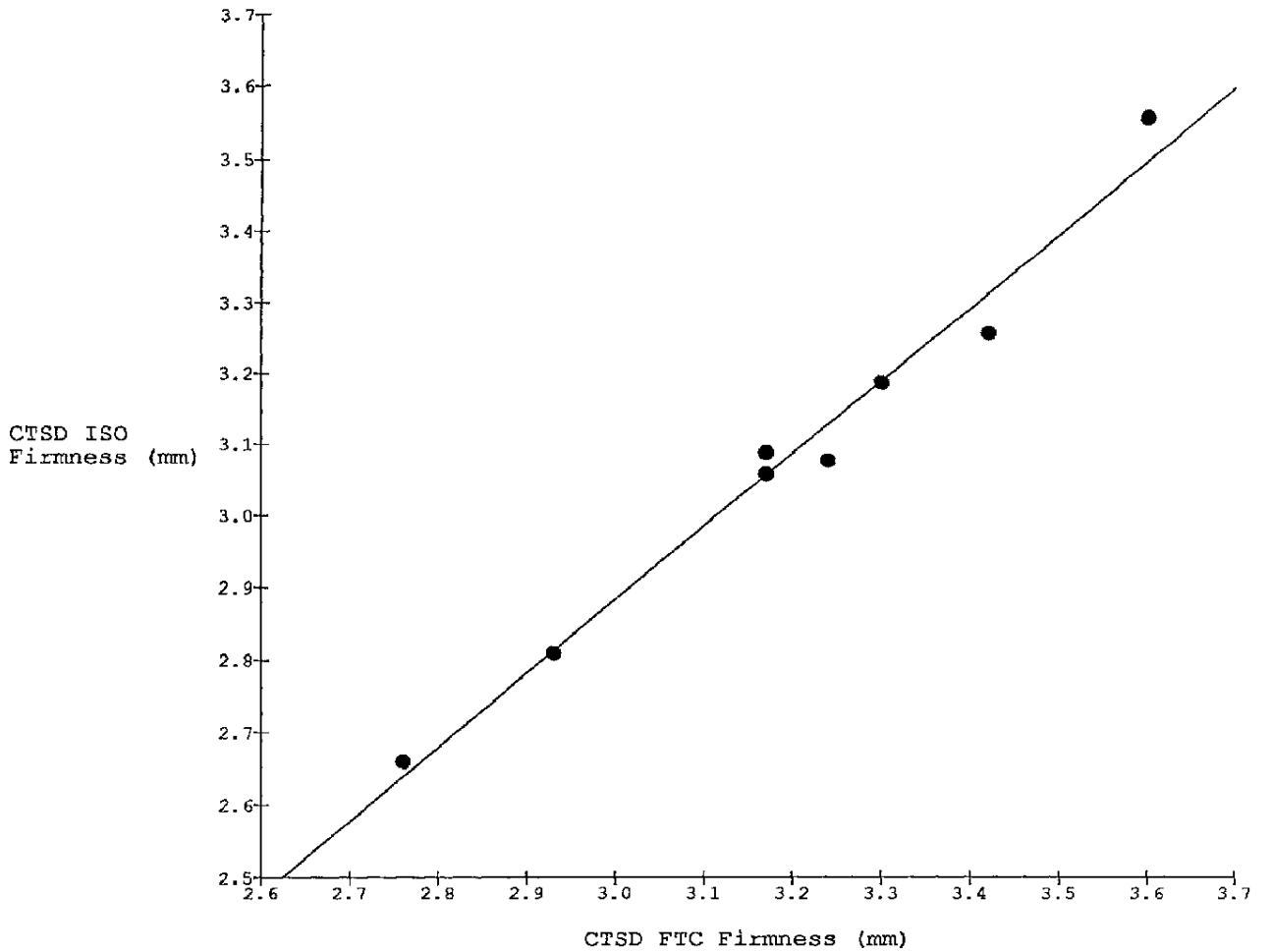
Figure II
As Is Firmness
CTSD FTC versus CTSD ISO



R2 = .98

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